

Density-Based Diamagnetic Separation: Devices for Detecting Binding Events and for Collecting Unlabeled Diamagnetic Particles in Paramagnetic Solutions

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Outline

- Experimental Goal
- Background: Diamagnetic Levitation
- Separation by density
- Microfluidic Design
- Testing
- Results
- Future Directions



Experimental Goal

- Design a microfluidic device to separate diamagnetic particles based on differences in density
- Benefits of using microfluidics:
 - Small, low-cost, portable
 - Can be used for diagnostics in remote locations

Background: Diamagnetic?



A live frog levitates in a magnetic field of about 16 T at the Nijmegen High Field Magnet Laboratory. Image courtesy of wikipedia.org

- Ferromagnetic
- Paramagnetic
- Diamagnetic!
 - Electrons generate a small B field **opposing** B_{ext}
 - F_B balances F_G , allowing levitation
 - <http://www.hfml.ru.nl/pics/Movies/frog.mpg>



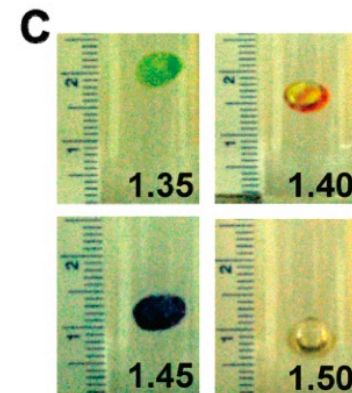
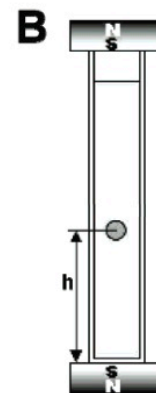
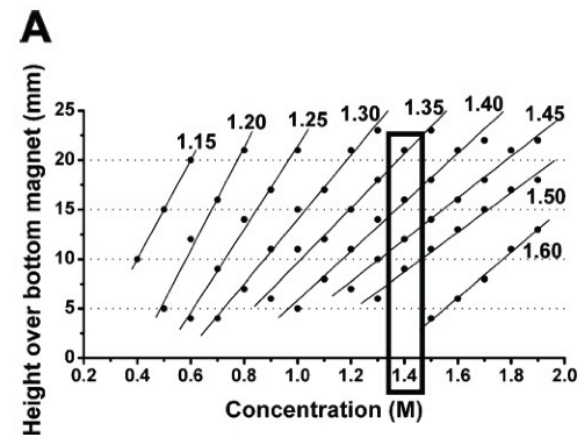
Levitating frogs is cool, but useless.

Why do we care about diamagnetic levitation?

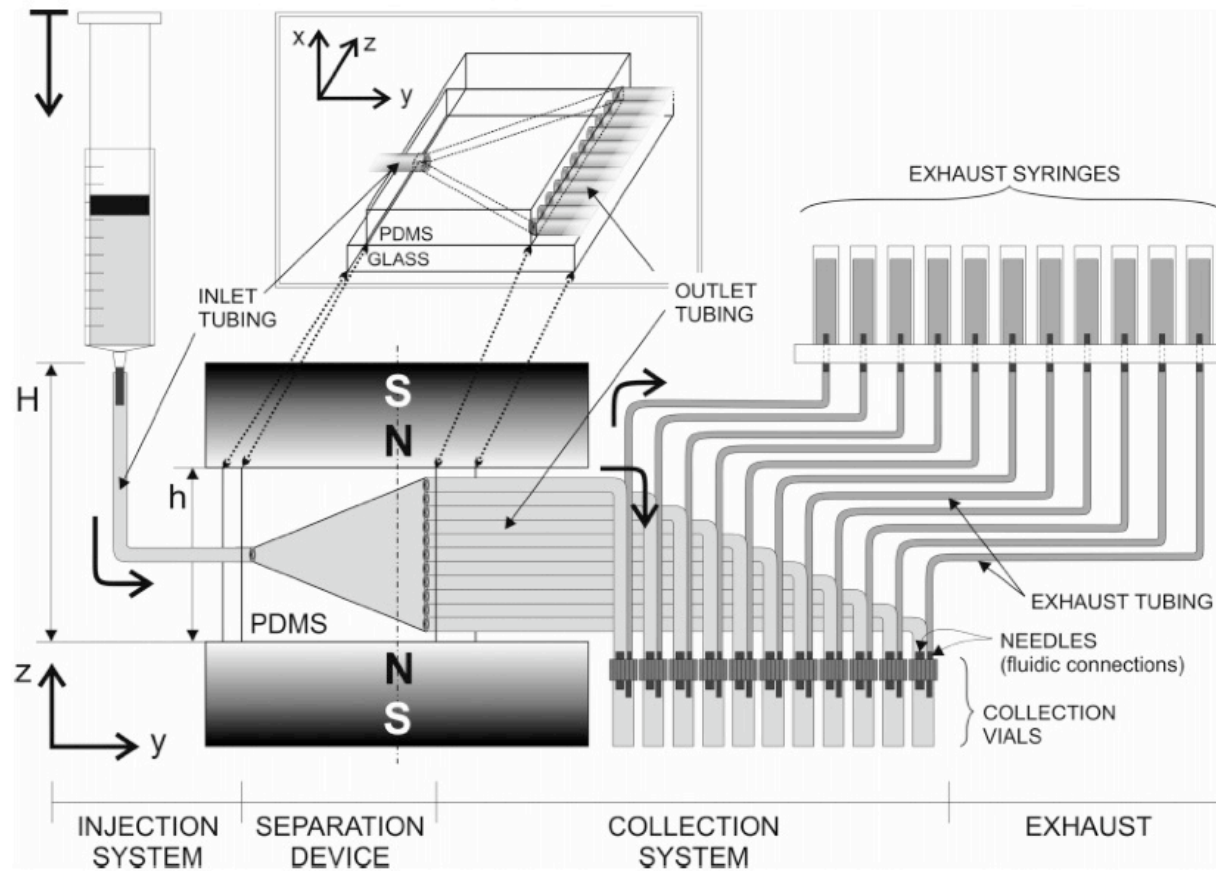
- Magnetic labeling in biological research has drawbacks
 - Labeling is binary, requires chemical reaction, changes functionality, and the label must be removed somehow
- Diamagnetic particles in a magnetic solution overcome these drawbacks
 - Unlabeled diamagnetic particles (eg. cells or antibodies) can be separated

Separating Beads by Density

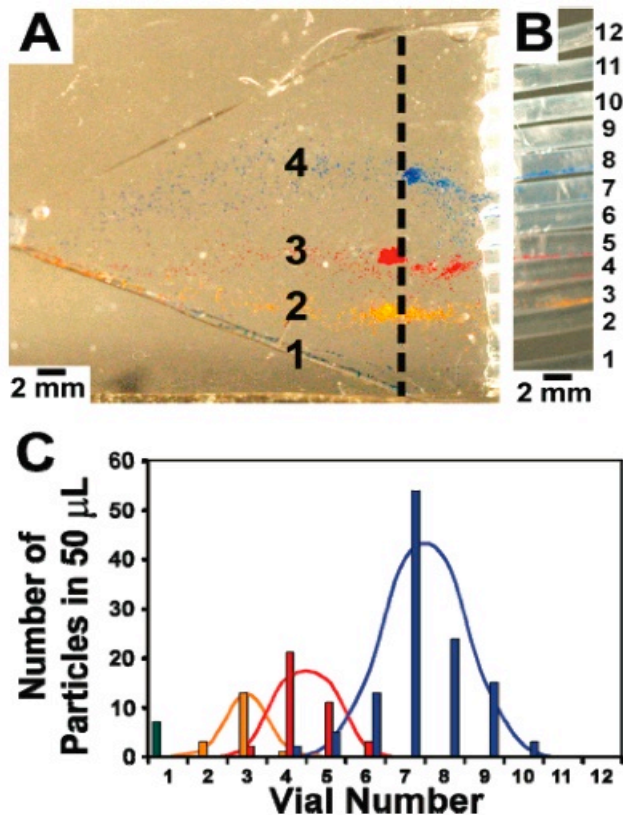
- Denser beads levitate in higher magnetic salt concentration (A)
- Levitation device, indicating h , height above bottom magnet (B)
- Color-coded glass spheres of varying density levitating in 1.4 M GdCl_3 (C)



Microfluidic Schematic

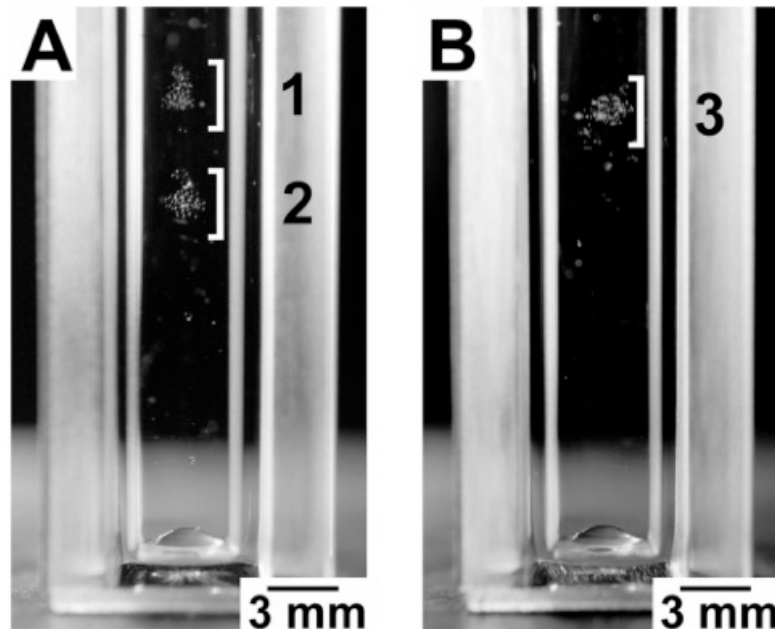


Microfluidic Device Testing

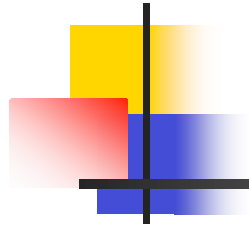


- Separation of particles based on density. (A)
- Separated particles in collection vials (B)
- Distribution of particles of varying densities (C)
- Note: tests verified that different dyes did not affect particle density

Biological Results



- (A) Biotin-labeled polymer with streptavidin (1) and without streptavidin (2)
- (B) Control: no biotin bound to polymer (3)



Future Directions!

- Mike and I are planning on working on this as our final project.
- Possible ideas:
 - More precise h measurement
 - Different kinds of beads
 - Binding to beads



Questions?
